Private 5G

A New Paradigm for Network Operators

Executive Summary

Setting the stage for a step function in enterprise connectivity

Private 5G represents the intersection of several important technology trends currently impacting the telecom industry. Digital transformation of industry, convergence of telco and IT, migration of cloud applications to the edge, and the increasing availability of spectrum are all conspiring to set the stage for explosive demand for private 5G.

The market for private cellular network infrastructure will be worth $5.7 billion by 2024, according to the analyst team at IDC, which sees the commercialisation of 5G as a major driver of investment in private networks.[i] Many mobile network operators and enterprises will see private 5G become foundational to their businesses in the coming years.

More than two thirds of global operators recently surveyed by GSMA Intelligence said they currently sell private wireless networks specifically deployed for enterprise customers. The vast majority of these operators have at least ten enterprise customers; 41 per cent have at least 50.

Many private wireless networks are already using 5G. According to the analyst team at GSMA Intelligence, private 5G networks have specific advantages over LTE, Wi-Fi and Ethernet. These include Ultra Reliable, Low-Latency Communications (URLLC); support for strict security, privacy and data isolation requirements; the ability to tailor 5G uplink and downlink bandwidth ratios to use cases; and the ability to implement network slicing, which can be applied within a private 5G network to create SLAs for specific devices and/or applications[ii].
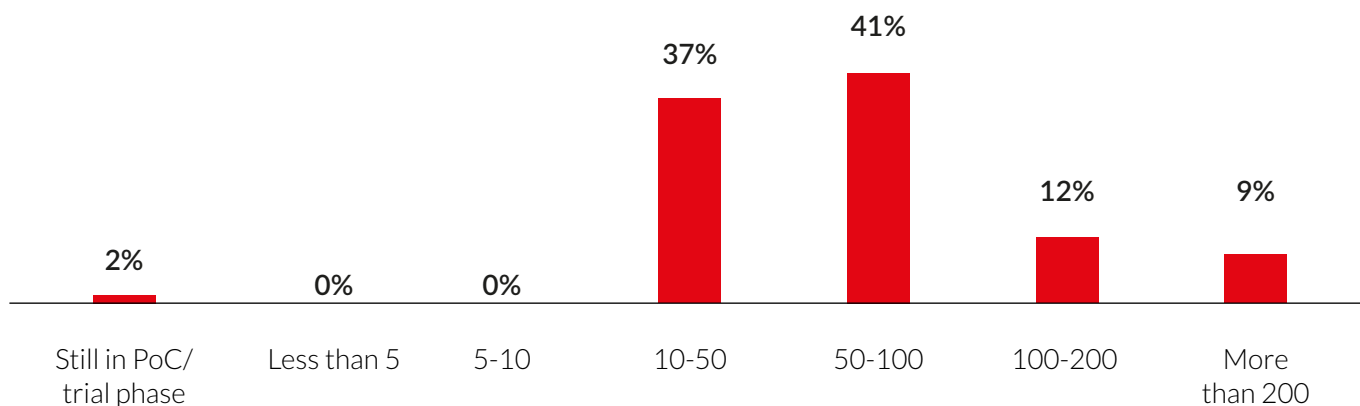
As network operators, vendors and enterprises work together, private 5G networks will add value to many processes, and may even be transformational for some companies. This whitepaper will explore the drivers of investment in this technology, the benefits for both operators and enterprises, and the technology paradigm for private networks.

Figure 1: Operators and private network status

Private networks

| 68% | 17% | 15% |

■ Currently sell ■ 2021-2022 ■ 2023-2025
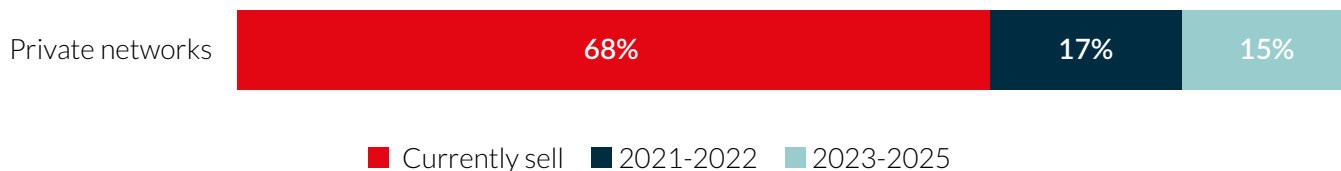
How many private network customers do you have?
Proportion of those that currently offer. N=68.

| Still in PoC/ trial phase | Less than 5 | 5-10 | 10-50 | 50-100 | 100-200 | More than 200 |
| 2% | 0% | 0% | 37% | 41% | 12% | 9% |

Source: GSMA Intelligence Operators in Focus Survey 2021

# What is driving investment in private 5G networks?

From factories to farms to hospitals to hotels, enterprises across industries are running the numbers on private 5G. Every industry has its own set of reasons for exploring the 5G opportunity. Healthcare facilities like Los Angeles' Ellison Institute for Transformative Medicine value private 5G for its ability to securely transmit large image files, while manufacturing giant Siemens is building a private 5G network in

Germany to enable mobile robots, autonomous vehicles, and augmented reality applications.

While most 4G use cases were built around the smartphone, private 5G use cases will be built around IoT devices. "In the enterprise sector the last thing to think about is smartphones", said Aniruddho Basu, SVP and GM, Emerging Business at Mavenir.

Private 5G has many use cases, most of which may still be undiscovered, but the myriad drivers of investment in private 5G can be grouped into three broad categories: digitisation, distributed computing systems, and democratization of spectrum.

Figure 2: Private network needs and investment plans among verticals
Percentage of respondents with localised network coverage requirement for IoT deployment.
Of those, percentage that have invested or are likely to invest in a private network. N= 2,772.
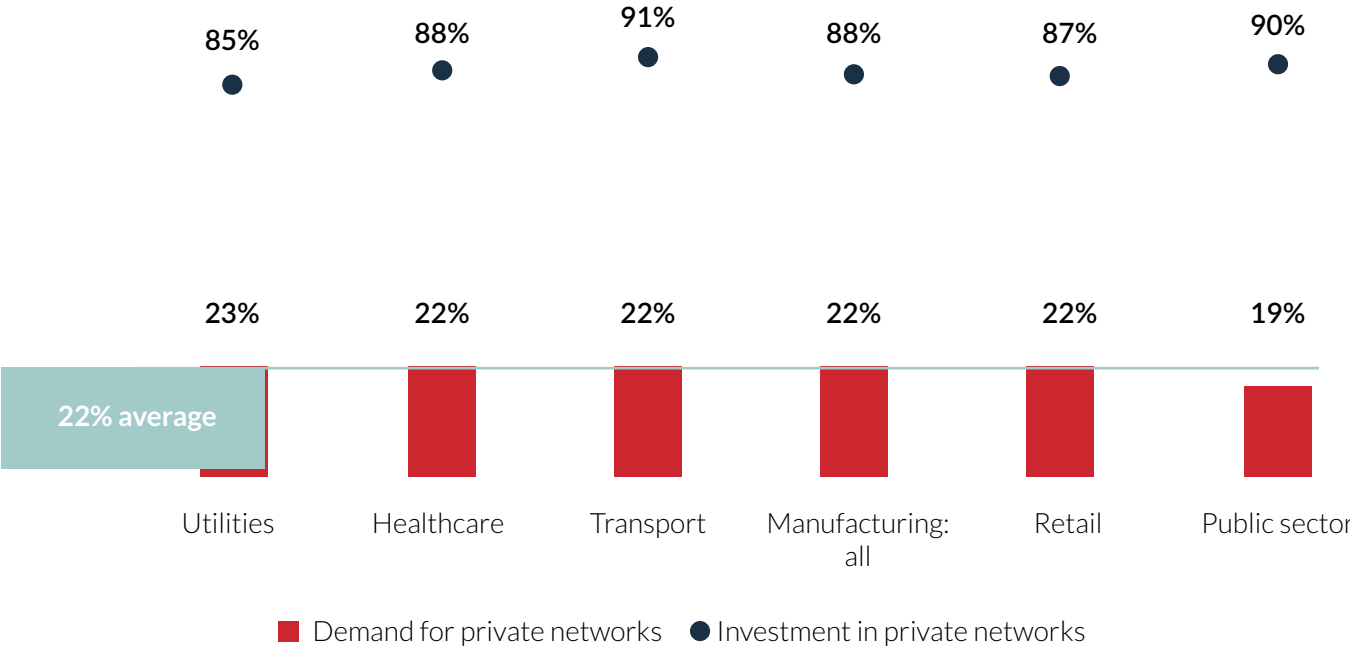
Source: GSMA Intelligence Enterprise in Focus Survey 2020

Digitisation

Many businesses that were unable to digitise operations and customer interactions didn't survive the pandemic, and those that did survive typically accelerated their digital journeys. As corporate networks become the backbones of businesses, IT managers are looking to private 5G to create dynamic architectures that can respond to the demands of applications and users by re-allocating bandwidth and re-prioritising traffic. Companies know their bandwidth needs will only increase with time, making the scalability of 5G attractive.

As enterprises digitise business processes, they typically see the need for more wireless connectivity. Wi-Fi has historically been less reliable and secure than cellular, but economics and ease of deployment made Wi-Fi the mobile technology of choice for IT departments, until recently.

"Some of the assets that made Wi-Fi a more cost-effective alternative are dissipating over time", said Basu. To varying degrees, governments around the world are making cellular spectrum available to enterprises that want to use it for business use cases rather than to resell services to third parties. That means Wi-Fi is no longer the only affordable and available spectrum for enterprise wireless. In addition, cellular devices are becoming easier to activate with the global adoption of eSIM technology, which could eventually erase another barrier to enterprise cellular networks.

Cellular is better suited than Wi-Fi for some operational technology (OT), according to the analyst team at GSMA Intelligence. Use cases that will benefit from private 5G include mobility support for autonomous guided vehicles in a warehouse or

intelligent video analytics to automate the quality inspection process on an assembly line that demands network requirements such as high throughput, high reliability, precise mobility, security, large device density and always-on operations. In the future, 5G Standalone (SA) will also deliver time-sensitive networking for high-precision devices.

Distributed computing systems

Cloud-based applications have transformed the business landscape, and now they are moving closer to end users with the proliferation of edge computing. Enterprises and independent developers are creating

applications designed for the network edge. These are apps that cannot reside in the cloud because of their low-latency requirements, but cannot be hosted on end-user devices because they are too large and use too much bandwidth. Examples include video analytics and augmented reality.

An engineer using an augmented reality application to understand how to repair machinery on a factory floor cannot be productive unless imagery renders in real-time, and this is possible with the speed of a 5G network with minimal latency. 5G protocols were created with enterprise use cases in mind, with industry consortia actively contributing to 3GPP Releases 15 and 16.
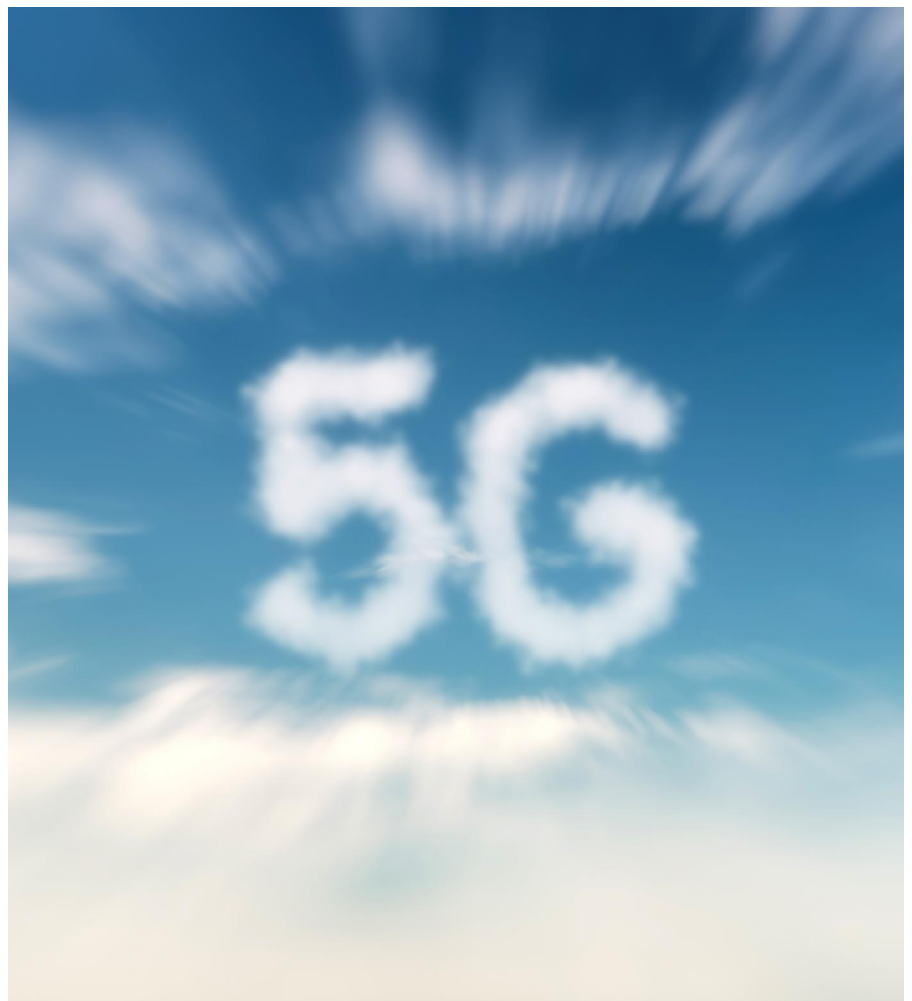
"5G is truly a technology that has actually been built ground up to cater for requirements that go beyond traditional consumer and mobile broadband," said Basu.

The promise of private 5G coupled with edge compute is very clear to the hyperscale cloud service providers. Microsoft's acquisitions of Affirmed Networks and Metaswitch, followed by its announcement that it will extend Azure into AT&T network operations centres to run the MNO's 5G Core, show the importance of private 5G to Microsoft. Private 5G is a major opportunity for the software giant, as evidenced by its integration of Microsoft Azure Stack Edge with Verizon 5G Edge.

Separately, Amazon Web Services (AWS), which will host Dish Network's 5G core, is also eyeing the private 5G opportunity, and the company will not wait for Dish to launch 5G before addressing the market. Already, AWS and Verizon have integrated Verizon's 5G Edge MEC platform with AWS Outposts, modular deployments of its cloud services meant for deployment at or near customer premises, which can be used for private 5G networks.

Democratisation of spectrum

In most industrialised countries, service providers no longer monopolise spectrum assets. Although regulators in each country approach spectrum democratisation differently, most of them are working to move at least some control of this asset into the enterprise sphere so that it can be deployed to advance business use cases. As a result, companies around the world are considering cellular as a viable option when they plan their networks.

Regulators in several Western countries have made the same spectrum bands available for commercial use. For instance, Germany, the US and The Netherlands are all permitting enterprises to use spectrum in the 3.7 GHz band for private networks. Spectrum harmonisation is a positive sign for the emerging ecosystem of industry-specific devices that can leverage private cellular networks.

The US government allows companies General Authorised Access to spectrum in the 3.55 – 3.7 GHz band, called Citizens Broadband Radio Service (CBRS). However, this spectrum is shared with the US Navy and with Priority Access Licence Holders, with access mediated by commercially available Spectrum Access Systems. This construct has dampened the enthusiasm of some potential users of private wireless, who are unsure how reliable their access to the free spectrum would be. A number of Priority Access Licences were purchased at auction by network operators and service providers. A handful went to enterprise users like John Deere, which is now actively investing in private 5G.

Germany has advanced private 5G more than most nations by not requiring enterprise users to compete with operators for spectrum licences. Instead, German companies are permitted to purchase spectrum from the government if they submit applications that explain their proposed use cases. (Selling services that use the spectrum is not an approved use case.)

So far, more than 70 German companies have acquired licences allowing them to use 100 MHz of spectrum in the 3.7GHz – 3.8GHz band. "There's a huge momentum to actively adopt 5G technologies and operators are actively trying to figure out where they can have a play, and they will have a play," said Basu.

The MNO Opportunity

Mobile network operators will participate in private 5G in a number of ways. Some private networks will be built, owned and operated by MNOs, while others will be controlled and managed by enterprise users, with operators acting as integrators and consultants. The vast majority of private 5G networks are likely to fall somewhere between these two extremes. For example, an enterprise may own its radio access equipment but use an operator's core network, or may deploy its own RAN and user plane but use an operator's control plane.

Operators are already selling private 5G networks to enterprise customers. NTT has launched a private 5G platform and will sell it as a service which can be run on premise, at the edge or in the cloud. Verizon has developed a product called OnSite 5G, a non-standalone private network that currently combines 5G and LTE radios with the LTE packet core. Likewise, Vodafone UK is using a combination of 5G and 4G to enable a private network for Ford at an electric vehicle factory in the UK. Over time, these deployments could migrate to full-fledged private 5G networks.

Some operators, including Deutsche Telekom, Telefonica and Vodafone are offering 'hybrid' 5G network solutions that offer flexibility by incorporating both public and private networks to suit a wider range of enterprise needs. [iii]

Private networks give MNOs the opportunity to evolve from being commodity connectivity providers to being value-added partners for their enterprise customers. "MNOs need to reinvent themselves a little bit," said Basu, "and grow their offering to go beyond simply delivering connectivity in the enterprise space. They will probably need to pivot towards being managed services and system integration and deployment partners."

In addition, private networks create a way for operators to earn revenue beyond the boundaries of their spectrum licences. For example, Verizon is building a managed private 5G network for the Port of Southampton in the UK.

Finally, most private 5G networks will need to interoperate with public networks, and this creates another

Main characteristics of deployment scenarios

Public network	Public network with SLAS	Public network with network slicing	Public network with local infrastructure	Standalone private network (operator spectrum)	Standalone private network (non-operator spectrum)
• Wide area mobility • Efficient use of infrastructure, operations and spectrum • Standard service-level agreements • Mobile edge computing within public network	• Leverages operator expertise, solutions and spectrum portfolio • Superior customer support and SLAS • QoS for prioritising critical devices and applications • Mobile edge computing within public network	• Network resources are dedicated and customised • Greater data isolation, security and privacy, and further SLA customisation (availability and reliability) • Edge computing on the operator edge	• Managed service with dedicated RAN under SLAS • Choices regarding localisation of data/control • On-site edge computing gateways • Interoperability with public network	• Dedicated network • Managed service or leasing of spectrum • Full control over design, deployment, operations and SLAS • Edge computing on the operator or customer edge	• Isolated network with no interoperability with public network • Direct responsibility for spectrum access and usage • Independent design, procurement, operation and radio plan

Source: GSMA Intelligence analysis

opportunity for MNOs. Organisations deploying private networks will need roaming agreements or similar arrangements with operators in order to track IoT devices or use enterprise applications outside the boundaries of private networks.

The Enterprise Opportunity

Private 5G networks are already helping enterprises in a variety of industries to cut costs, reduce energy use and analyse business critical data in real-time.

Enterprise cost savings delivered by private 5G fall into two broad categories: savings generated by faster access to better data, and savings generated by operational flexibility. For example, agtech start-up AeroFarms is using drone-mounted cameras connected to private 5G to collect, transmit and analyse crop images at its vertical farms. This accelerates the processes of identifying crop variations, and of developing new crops. Operational flexibility derived from private 5G is typically seen in the factory setting, where production lines can be reconfigured without rewiring and reconnecting equipment. For instance, John Deere is deploying a private network using CBRS spectrum at two US factories in order to bring more agility to the factory floors.

When private 5G is combined with edge compute resources, real-time data analytics can produce actionable intelligence for the enterprise. Retailers can push appropriate digital offers to consumers who are making purchase decisions and can restock supplies before they run out. Transportation hubs can move freight on autonomous vehicles and use

robots to unpack boxes, and municipalities can analyse data in real-time to improve the quality of life for their citizens.

In Ban Chang, Thailand, Mavenir is building an open RAN network with smart city specialist 5GCT, along with Cisco and Thailand's National Telecom Public Company Limited. The network enables exciting new IoT use cases, including smart light poles for detection of airborne toxins and dust levels within the city, and safeguarding the local community with the implementation of an SOS button into every 5G smart pole.

Data analysis at the network edge also has applications in the healthcare setting. In Los Angeles, AT&T deployed a private 5G network for the Ellison Institute for Transformative Medicine. The hospital was already using artificial intelligence to analyse tumor images, and the 5G network will enable clinicians to move this analysis from the cloud to the hospital premise. For cancer patients this will mean faster results and more data security.

There are many more examples of diverse vertical use cases deployed on 5G networks. With spectrum dedication and basic 5G capabilities in place, the focus is also shifting to SA deployments. The device and chipset ecosystem to enable 5G SA capabilities is evolving rapidly and it is expected that by the end of 2021, devices in varied form factors will be commercially available for enterprise use cases.

According to Vinay Dhar, SVP Business Development, Emerging Business, at Mavenir, more enterprise use cases for private 5G will develop as the IoT device ecosystem matures. "The device ecosystem building on 5G SA is in the early phase of its evolution– getting a robust ecosystem of

devices together is key to being able to really scale the 5G private network connectivity for enterprises," he said. "When it comes to developing a robust ecosystem, considerations regarding how an enterprise works with the ecosystem are key. How does an organisation work with chip companies and what devices will be used? What factors come into play for the hardware infrastructure? What architectures and network functions are provided by network solution providers? These considerations extend to cloud players, Communications Service Providers (CSPs), system integrators, and technology integrators as well. Enterprises will come to rely on the power of the ecosystem to drive innovation, which will in turn drive the market."

The technology paradigm for 5G private networks

Private networks rely on technology from public carrier networks as well as enterprise IT, bringing together two disciplines that have until now developed along very different trajectories.

IT networks need to be flexible, and in recent years commodity hardware and cloud-based applications have given rise to horizontally agile enterprise networks that easily scale up and down.

Telco networks are more vertically integrated and tend to be more resilient. They are also characterised by proprietary technologies that are not well understood outside the industry. These technologies need to adapt in order to gain traction in enterprise IT environments. Mavenir's Aniruddho Basu sees a need to "fundamentally make these

Private 5G networks: unlocking value for operators and enterprise

Telecom networks can be the platform for innovation in industry and society, if operators and their partners adopt open, cloud-based, software-driven architectures and embed automation. The companies that will dominate the business landscape are already embracing continuous innovation/continuous deployment and designing digital twins to monitor their internal networks. Mobile network operators and their vendors are well-positioned to help lead this transformation by providing intelligent, accessible connectivity solutions.

Mavenir's Private Network solution is purpose-built for the evolution to 5G and the increased demand for use cases and applications that address the needs of enterprises, industries and service providers. Mavenir's end-to-end 5G system is based on cloud-first, open architecture principles, and is highly suited to address private network capabilities for CSPs, enterprises and also non-traditional networks, such as aviation, maritime, rural and remote networks.

With 5G private networks to enable secure connectivity while collecting and managing massive amounts of business-critical data, enterprises and industries can accelerate their digital journeys. Private 5G is not only a new paradigm for network operators, it is also an exciting opportunity for public and private enterprises to unlock efficiencies, leverage data in real-time, and generate new revenue.

networks more IT like" to incentivise adoption outside the telecom industry.

Open architectures and open interfaces are an important element in the process of making telco technology more accessible to the enterprise. Basu said open interfaces need to extend all the way to the radio access network, which is the part of the network IT departments may interact with the most.

"The enterprise will never want to build up telecom management experience," Basu explained. Instead, enterprises need solutions that are open, interoperable and automated, replacing the "opaque and obtuse cellular technologies which nobody has ever understood except us in the telecom industry".

Adoption of open architectures in enterprise environments will lead to innovation, as more developers

become familiar with cellular technology. This will in turn lead to new solutions, which can increase competition and drive down prices.

Bringing more developers into the ecosystem will also increase the number and variety of enterprise applications that can leverage 5G. Verizon has recognised this already and has launched a portal to enable software developers to more easily integrate AWS cloud-based applications with the Verizon network.

Just as 4G created an app economy targeting consumers, 5G has the potential to create an "app store" for industry and enterprise. A scalable, interoperable, reliable connectivity platform gives developers the confidence to create without worrying about what's going on "under the hood". This is the foundation of a network-based economy.

Mavenir is building the future of networks and pioneering advanced technology, focusing on the vision of a single, software-based automated network that runs on any cloud. As the industry's only end-to-end, cloud-native network software provider, Mavenir is focused on transforming the way the world connects, accelerating software network transformation for 250+ Communications Service Providers in over 120 countries, which serve more than 50% of the world's subscribers.

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